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HAZARDOUS WASTE

DOD Estimates for Cleaning Up Contaminated Sites Improved but Still Constrained

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The Honorable Frank R. Lautenberg
Chairman, Subcommittee on Superfund,
Ocean and Water Protection
Committee on Environment and Public Works
United States Senate

The Honorable Richard Ray
Chairman, Environmental Restoration Panel
Committee on Armed Services
House of Representatives

The Honorable John Conyers, Jr.
Chairman, Subcommittee on Legislation
and National Security
Committee on Government Operations
House of Representatives

The Honorable John W. Warner
United States Senate

The Honorable James V. Hansen
House of Representatives

As you requested, we reviewed the Department of Defense's (DOD) estimates of the cost to identify and contain or clean up hazardous waste sites. Specifically, our objectives were to identify (1) the reasons why DOD has had difficulty developing a reliable estimate and (2) what efforts DOD is making to produce better estimates. We did not prepare any cost estimates. DOD's current official cost estimate to clean up its hazardous waste sites, released in September 1991, is $24.5 billion (1991 dollars). This estimate updates DOD's 1988 estimate with an estimate range from $8.5 billion to $12.8 billion (1987 dollars), depending on the extent of the cleanup. DOD's newest estimate is almost double the 1988 estimate.

Background

DOD may be responsible for cleaning up hazardous waste that has been disposed of in sites on (1) active installations, (2) land formerly owned or used by DOD, or (3) other sites, such as those used by DOD contractors. Most of DOD's sites are on active installations. In many cases, an installation will have more than one site within its boundaries. DOD's site

categories include landfills and underground storage tanks, as well as DOD-unique explosive/ordnance disposal areas, and fire training areas. The size of a site can range from a small storage tank to a large landfill.

Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as Superfund, in 1980. The act calls for a program to identify inactive hazardous waste disposal sites and to ensure that remedial actions[1] are taken by the responsible parties at each site. Federal agencies are subject to the same requirements of the act as private entities. DOD's primary program for identifying and containing or cleaning up hazardous waste sites is its Installation Restoration (IR) Program. DOD has so far identified almost 24,500 potential hazardous waste sites.

The Superfund Amendments and Reauthorization Act of 1986 modified the act, including requirements for the development of criteria to select a specific cleanup remedy for a site. The Environmental Protection Agency's implementing regulations outline cleanup requirements, state and local government participation in the cleanup program, and the procedures for selection and approval of remedial actions. The Defense Environmental Restoration Program focuses on identifying and remedying contamination at DOD installations. The IR Program is the primary component of the Defense Environmental Restoration Program. It has three phases designed to assess, study, and contain or clean up contaminated sites at DOD installations. (See app. I.)

Results in Brief

A number of factors have affected DOD's ability to develop a reliable estimate of how much it will cost to clean up its hazardous waste sites. These factors include: (1) all the sites that DOD may ultimately have to clean up may not have been identified, (2) studies to identify what contamination is in the sites have not been completed, (3) some installations will require more extensive cleanup than anticipated, and (4) timing of the cleanup is not known and the longer it takes DOD to begin the cleanup, the higher the cost could be. In 1985, DOD's cost estimate ranged from $5 billion to $10 billion for assessment, study, and potential cleanup of 400 to 800 sites. In 1989, one estimate of DOD's potential costs

[1]Remedial actions are those actions taken to clean up sites or to prevent or minimize the release of hazardous substances so that they do not move to cause substantial danger to public health or the environment. Some examples of remedial actions are incineration of contaminated soil, groundwater treatment, and building decontamination.

ranged from $4.2 billion (including 2 years of operation and maintenance costs) to $42.2 billion (including 20 years of operation and maintenance costs) depending on the technology needed. This estimate was for remedial actions at just over 7,100 sites. The 1985 estimate was based on limited study and research, while the 1989 estimate was produced to examine the types of cleanup options available. Some of the other estimates were updates of previous estimates or were based on projected cleanup costs of individual sites.

DOD's newest cost estimate is $24.5 billion. In developing its estimate, DOD has drawn on its experience in study and cleanup activities. In addition, the services have been actively involved, and DOD has used historical costs rather than projections in developing its estimate. However, because DOD is still assessing the cleanup required and identifying more sites, it is possible that future DOD estimates will be even higher.

Past Cost Estimates

Over the years, the estimates to clean up DOD's hazardous waste sites have increased significantly, mainly because more sites are constantly being discovered. In addition, different factors have affected the final estimates. (See app. II.) We reviewed the current $24.5 billion cost estimate and five past cost estimates: two are official DOD estimates; one is an estimate resulting from a study of cleanup alternatives; and two are estimates that build on past estimates, which did not result from new data or study.

- In 1985, DOD estimated the cleanup would cost from $5 billion to $10 billion. Its estimate was based on the 400 to 800 potential sites anticipated at the time, even though about 270 of the then-identified 400 sites were still under study.
- In 1988, a DOD contractor estimated the cleanup would cost between $8.5 billion and $12.8 billion. Its estimate was based on cost projections for the next 5 to 7 years for the IR Program. At the time DOD had identified over 12,000 potential sites for the IR Program.
- In November 1989, DOD estimated the cost would be between $11 billion and $15 billion (1987 dollars). DOD rounded off the 1988 estimate and included an estimate for the Rocky Mountain Arsenal.[2] By the end of

[2]Rocky Mountain Arsenal could be DOD's biggest, most expensive cleanup. Litigation has been ongoing to determine cost liabilities for hazardous waste cleanup at Rocky Mountain Arsenal. The Army hesitates to release cost information because it might influence the outcome of the litigation. However, it was willing to say that cleanup could cost up to $2 billion. Shell Oil Company produced pesticides at Rocky Mountain Arsenal in the past, so it will be sharing in the cost of cleanup.

fiscal year 1988, however, the number of identified sites had increased 24 percent, to 15,257. At the time, many studies were still incomplete.

- In 1989, a DOD contractor estimated the cost would be between $4.2 billion and $42.2 billion, depending on the years of operation and maintenance funding covered and the extent and type of cleanup involved. It used a model it had developed for the Environmental Protection Agency. The estimate considered about 7,100 sites for remedial actions, but did not include Rocky Mountain Arsenal or some other sites for which DOD could be liable. This study was initiated to provide information to environmental officials and not to provide a final estimate, according to a DOD official.
- In May 1990, the Congressional Budget Office converted the 1988 estimate to 1989 dollars, which increased the cost to between $10.4 billion and $16.3 billion. By the end of fiscal year 1989, however, the number of sites had increased from fiscal year 1987 by 74 percent, to 21,519.

Reliability of Cost Estimates

Although DOD's new cost estimate should be more reliable than those prepared in the past, it will still be limited by at least four important factors. First, the estimate may not include all the sites DOD will have to clean up. It does not include overseas installations or sites at installations nominated for closure or realignment by the Base Realignment and Closure Act of 1988. The number of potential sites has doubled since 1987. Although DOD environmental officials do not expect to discover any new sites requiring extensive cleanup, each new site will require some investment to assess the extent of contamination and any remedial action necessary.

Second, most studies of existing sites have not been completed. Of the almost 7,000 sites identified through 1990 that DOD has determined require further study, only about 900 studies have been completed. Third, the longer it takes to complete the studies and necessary remedial actions, the higher the costs may be. Not only will inflation, which is likely to occur, cause the costs to increase, but DOD may also have to clean up the sites to comply with more stringent standards. On the other hand, advances in technology may offer DOD less expensive technology for cleanups. Fourth, some installations are requiring more cleanup than originally anticipated. For example, in fiscal year 1982, McClellan Air Force Base had identified 46 sites on the installation with an estimated cleanup cost of $29 million. By fiscal year 1990, it had identified 177 sites and had received $61 million.

Scope and Methodology

We interviewed officials responsible for the Installation Restoration Program and related environmental issues within each military service. We also discussed the program with selected installations to assess the type and quality of cost data input into the various management information systems. In addition, we assessed hazardous waste cleanup cost data available at the agencies responsible for managing the cleanup efforts: the Army Corps of Engineers; the U.S. Army Toxic and Hazardous Materials Agency; the Air Force's Environmental Quality Division; and the Naval Facilities Engineering Command, Environmental Restoration Division.

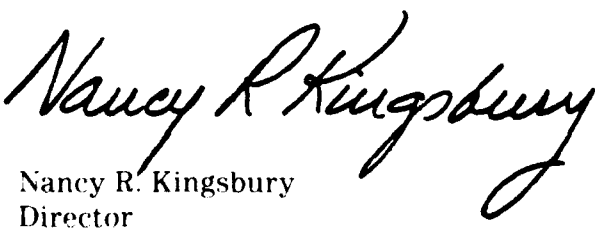
We did not determine whether DOD's program to identify and correct hazardous waste problems is in full compliance with Environmental Protection Agency regulations.

Our work was done primarily in Washington, D.C., at the Office of the Secretary of Defense and the services' headquarters. We conducted our work from May 1990 through August 1991 in accordance with generally accepted government auditing standards.

As you requested, we did not obtain official agency comments on this report. However, we discussed the report with DOD officials and incorporated their comments where appropriate.

Unless you publicly announce its contents earlier, we plan no further distribution of the report until 30 days after its issue date. At that time, we will send copies to appropriate congressional committees; the Secretaries of Defense, the Army, the Navy, and the Air Force; and the Director of the Office of Management and Budget. We also will make copies available to others upon request.

Please contact me at (202) 275-4268 if you or your staffs have any questions concerning this report. Other major contributors to this report are listed in appendix III.



Nancy R. Kingsbury
Director
Air Force Issues

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Abbreviations

DERA	Defense Environmental Restoration Account
DOD	Department of Defense
EPA	Environmental Protection Agency
GAO	General Accounting Office
IR	Installation Restoration
NPL	National Priorities List

DOD's Installation Restoration Program

The Department of Defense (DOD) has several activities underway to ensure its compliance with environmental regulations. The Defense Environmental Restoration Program focuses on identifying and remedying contamination at DOD installations. The primary component of the Defense Environmental Restoration Program is the Installation Restoration (IR) Program. It has three phases designed to assess, study, and remediate contaminated sites at DOD installations.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 required a program to identify inactive hazardous waste disposal sites. Later, the Superfund Amendments and Reauthorization Act of 1986 modified the act and required the development of criteria for selecting a specific site cleanup remedy.

Installation Restoration Program Components

DOD uses its Defense Environmental Restoration Program, established in 1984, to evaluate and clean up contamination at its installations. Defense Environmental Restoration Program activities receive most of their funds from the Defense Environmental Restoration Account appropriation.[1] Defense Environmental Restoration Program funding from this account has risen from $150 million in fiscal year 1984 to $1.06 billion in fiscal year 1991. In fiscal year 1990, the IR Program received 96 percent of the Defense Environmental Restoration Program funding. Because DOD allocates most of the Defense Environmental Restoration Program funding to the IR Program each year, we focused our review on the IR Program.

The original Defense Environmental Restoration Program contained four components: the IR Program, Other Hazardous Waste Operations, Building Demolition and Debris Removal, and Hazardous Waste Disposal. However, since 1987, only IR Program and Other Hazardous Waste Operation activities have been conducted under the program. DOD uses the IR Program to identify and clean up inactive hazardous waste sites that are contaminating or have the potential to contaminate the environment. The program operates at many DOD installations in the United States and its possessions and territories, but not in foreign countries. DOD is developing a plan to address remedial actions and cleanup for

[1]Defense Environmental Restoration Account monies need not be obligated in the year in which they were appropriated; account balances may be carried over from year to year. Account monies must be transferred into another account for use. Once transferred, the monies take on the characteristics of the new account. For example, account monies transferred to the operation and maintenance account become 1-year funds. Monies not spent in the allotted time (by the end of the fiscal year in the above example) will be returned to the Defense Environmental Restoration Account, according to DOD officials.

environmental problems caused by past activities at overseas installations.

The IR Program has three phases: Preliminary Assessment/Site Inspection, Remedial Investigation/Feasibility Study, and Remedial Design/Remedial Action.

1. Preliminary Assessment/Site Inspection: This is the initial phase of the IR Program. The preliminary assessment is a study of the entire installation to determine if any contamination exists that may pose hazards to health or the environment. It identifies what potential hazardous substances were used or are used on the installation. Once potential problem areas are identified, the installation uses the site inspection to determine the existence of actual contamination.

2. Remedial Investigation/Feasibility Study: This phase includes sampling and analytical activities to determine the nature, extent, and significance of the contamination, as well as any risk to the general population. Concurrently with the investigation, feasibility studies are conducted to evaluate the cleanup alternatives for the site.

3. Remedial Design/Remedial Action: After appropriate federal and state regulatory officials agree with DOD on cleanup actions, they draw up and implement detailed cleanup plans. Remedial Design/Remedial Action may be followed by site operations, maintenance, and long-term monitoring or treatment (referred to as long-term operation and maintenance costs by DOD).

For the remainder of this report we will refer to these phases as assessment, study, and remedial action, respectively.

The Comprehensive Environmental Response, Compensation, and Liability Act requires the Environmental Protection Agency (EPA) to establish criteria for setting priorities among all sites needing remedial action, including DOD's. Sites that score high on EPA's evaluation system are nominated for EPA's National Priorities List. DOD has 95 active installation sites and 11 formerly owned or used sites on the list.

DOD Hazardous Waste Sites

Identifying the number of sites requiring action is an important first step in estimating total cleanup costs. DOD hazardous waste has been disposed of in sites on (1) active installations, (2) land formerly owned or used by DOD, or (3) disposal sites never owned by DOD. Most of DOD's sites

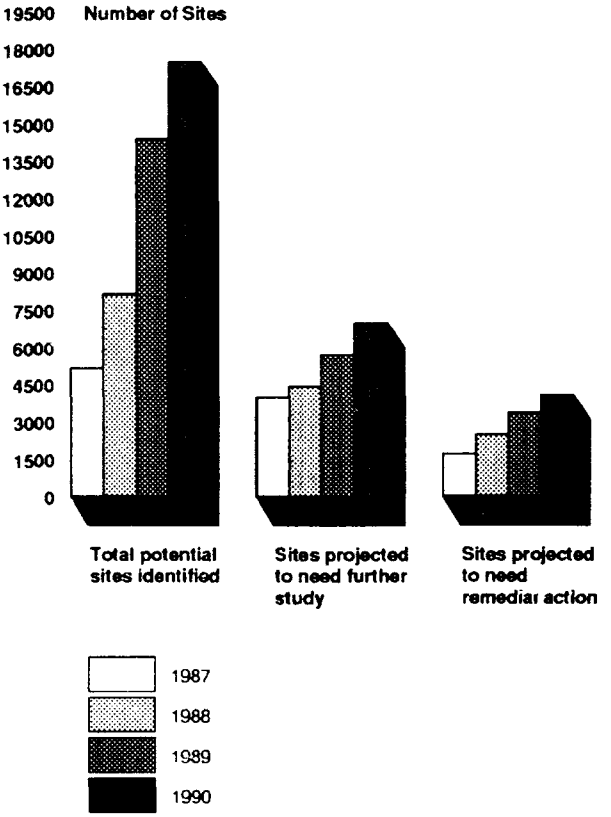
are on active installations. As of September 1990 (the latest information available when we did our review), DOD had identified almost 17,500 potential sites on active installations. DOD has also identified 6,980 potential sites on land once owned or used and is a potentially responsible party on 185 sites on land where its hazardous waste was disposed of. Each site must go through each phase of the IR Program until DOD, in coordination with federal and/or state regulatory officials, determines that the site requires no further action. When a site requires no further action, the officials believe the site does not pose a hazard to health or the environment, based on existing criteria. This decision can be made during any phase.

By the end of fiscal year 1990, DOD had completed remedial actions on only 296 sites. These sites tend to be small, less complicated sites, such as underground storage tanks. Another 1,191 sites had remedial actions underway. Cleanup actions have begun at 83 of the 95 DOD active installation sites on the National Priorities List, although cleanup has not been completed at any sites as of July 1991.

Active Installation Sites

As of September 1990, DOD has identified 17,482 potential hazardous waste sites on about 1,900 active installations in the United States, its territories, and possessions. About 40 percent of these sites required further study, as shown in figure I.1. DOD determined that about 40 percent of the sites pose no hazard to public health or the environment, based on existing criteria, and required no further action. DOD is uncertain whether the remaining 20 percent of the sites will require further study.

Figure I.1: Status of IR Program at Active Installations (Fiscal Years 1987 Through 1990)



Source: Defense Environmental Restoration Program: Annual Reports to Congress (Fiscal Years 1987 through 1990).

Of the active installation sites requiring further study, DOD projected that about 60 percent will require some type of remedial action.

Formerly Owned or Used Sites

For contaminated or potentially contaminated sites on land DOD once owned or used, DOD has assessed 2,369 of 6,980 sites (34 percent). About 1,600 sites have been found eligible[2] for its cleanup program. About 80 percent of these eligible sites will require some sort of remedial or removal action, according to DOD projections.

[2]Not all sites on formerly owned or used land are eligible for restoration under this program. Information on the origin of the contamination, current ownership, and any land transfers must be examined by DOD first.

Other Non-DOD Sites

A number of sites are being identified where DOD may be a responsible party. These sites, referred to as third party sites, are generally sites never owned by DOD, but where DOD hazardous waste was disposed of. Under Superfund requirements, anyone who puts hazardous waste in a site, directly or indirectly, is subject to paying part or all of the cleanup costs if the environment is contaminated. Therefore, DOD could be liable for cleaning up all or part of these sites. As of July 1991, 185 sites are involved.

The Defense Authorization Act for Fiscal Years 1990 and 1991 tasks DOD to "develop and maintain a comprehensive database on environmental activities" and to submit a comprehensive report on its long-range environmental challenges and goals. The report is due November 1991. According to one DOD official, the report will cover a broad range of environmental issues, including the department's estimate of the costs of hazardous waste cleanups at both U.S. and overseas installations. One DOD official told us that the preliminary report draft includes only an estimate for the Defense Environmental Restoration Program and a figure for overseas installations in the hazardous waste section. However, the overseas installations information was not gathered in the same systematic or in-depth manner as the U.S. installations information was gathered.

Cost Estimates to Clean Up Hazardous Waste Sites

DOD's procedures for developing cost estimates has improved over the years as it has gathered more data about hazardous waste cleanup. In the past, estimates varied considerably. In 1985, DOD estimated that the total cleanup costs would range between $5 billion and $10 billion. By 1988 DOD's official estimate ranged from $8.5 billion to $12.8 billion (1987 dollars), depending on the extent of cleanup and treatment or monitoring necessary. DOD's newest IR Program estimate is almost double the 1988 estimate at $24.5 billion (1991 dollars) for known sites.

A number of factors have affected DOD's ability to develop a reliable estimate of how much it will cost to clean up its hazardous waste sites. These factors include: (1) all the sites that DOD may ultimately have to clean up may not have been identified, (2) studies to identify what contamination is in the sites have not been completed, (3) some installations will require more extensive cleanup than anticipated, and (4) timing of the cleanup is not known and the longer it takes DOD to begin the cleanup, the higher the cost could be.

Wide Range of Cost Estimates

DOD officials credit three factors for the increasing cleanup cost estimates: (1) the number of potential sites to examine is growing (see fig. I.1), (2) better data are available as more assessments and studies are completed, and (3) state and federal standards are becoming stricter. We reviewed six estimates of DOD costs: three are official DOD estimates; one is an estimate resulting from a DOD-initiated study of cleanup alternatives; and two are estimates that build on past estimates, which did not result from new data or study. Table II.1 compares the coverage of past cleanup cost estimates for DOD.

Table II.1: Comparison of Cost Estimates for DOD Hazardous Waste Site Cleanup
(Then-Year Dollars)

Dollars in billions

Component/year	1985	1988	November 1989	1989	1990	1991
Estimate range	$5–10	$8.5–12.8	$11–15	$4.2–42.2	$10.4–16.8	$24.5
Active installations	X	Y	Y	Y	Y	Y
Formerly owned or used land	*	Y	Y	N	Y	Y
Third party	*	Y	Y	N	Y	Y
Rocky Mountain Arsenal	*	N	Y	N	N	Y
All phases	*	Y	Y	N	Y	Y
Operation & maintenance (years)	*	2	2	2–20	2	10

Key
Y = specifically mentioned as covered
N = specifically mentioned as not covered
X = covered, but not separated out
* = unknown

In 1985, DOD estimated it would cost $5 billion to $10 billion to clean up all hazardous waste sites, but one DOD official referred to the estimate as "back-of-the-envelope" because it was not based on extensive research or analysis. This estimate, provided to Congress in DOD's testimony before the Subcommittee on Military Construction, House Committee on Appropriations, was based on the cost to study and clean up about 400 to 800 potential hazardous waste sites identified by DOD at that time. According to DOD's Director of Environmental Policy, at the time the estimate was prepared DOD was uncertain of the figure because the agency still had about 270 sites in the study phase.

Subsequently, DOD contracted with the Mitre Corporation to prepare an estimate based on research and analysis. In 1988, Mitre estimated it would cost between $8.5 billion and $12.8 billion (1987 dollars) to complete the IR Program. Because most of DOD's data consisted of projections for the next 5 to 7 years, the contractor used various methods to extrapolate and supplement the cost data to project a total DOD cost to complete the program. The contractor did not independently develop and/or verify any cost information. Estimated costs for site operations, maintenance, and long-term monitoring were included for 2 years only.[1] Although Mitre identified the cost by installation rather than by site, the

[1]At the time of the study, the Defense Environmental Restoration Account was used for costs for site operations, maintenance, and long-term monitoring for 2 years. Currently, the account can be used for up to 10 years of these costs; funding after 10 years must be provided by other DOD sources.

final cost range included all active sites, formerly owned or used sites, and third party sites, but excluded Rocky Mountain Arsenal. In its Defense Environmental Restoration Program annual report for fiscal year 1987, DOD had identified 12,342 potential sites, including active installations and formerly owned or used sites.

In November 1989, the Deputy Assistant Secretary of Defense (Environment) estimated that DOD's cleanup costs would be between $11 billion and $15 billion (1987 dollars). He also stated that the total funding requirement was uncertain because many studies were still not completed. According to DOD officials, this estimate was the 1988 study's figures rounded plus an estimate for the Rocky Mountain Arsenal. However, by the end of fiscal year 1988, the number of potential sites identified by DOD had increased to 15,257, or about a 24-percent increase from fiscal year 1987.

The Congressional Budget Office, in its May 1990 report, converted Mitre's 1988 estimate to 1989 dollars, which increased the range to between $10.4 and $16.8 billion. However, simply factoring in inflation did not provide a reliable cost estimate because by fiscal year 1989, the number of potential sites had increased by about 74 percent, from 12,342 to 21,519.

In 1989, CH2M Hill, a contractor, developed an estimate using a model it had developed for EPA 3 years earlier. The estimate used 7,135 sites, the number CH2M Hill had projected would require remedial actions in the future. The estimate included only the cost to clean up sites or otherwise complete a designated remedial action. It did not include the costs to assess or study the sites as did previous estimates. In 1988 dollars, the estimate ranged from (1) $4.2 billion for solutions relying on containment (little or no treatment) and 2 years of treatment and monitoring costs to (2) $42.2 billion for high technology remedial actions[2] and 20 years of treatment and monitoring costs. This estimate range did not include Rocky Mountain Arsenal, sites on formerly owned or used properties, or any estimate of costs due to third party site actions. DOD does not consider it an official estimate because the study was not initiated to update the 1988 Mitre study. This study was done to provide an analysis of alternatives for cleanup. It was meant to provide working information for environmental officials.

[2]The contractor defined high technology remedial actions as those that reduce volume, toxicity, mobility; are permanent, on-site solutions; and involve new or innovative technology.

DOD's Newest Cost Estimate

A DOD contractor prepared an updated cleanup cost estimate for its IR Program. In the report, DOD estimates that it will spend $24.5 billion (1991 dollars) to study and remedy, where necessary, all previously identified potential sites, which number almost 24,500.

DOD officials believe the estimate will be more reliable than previous estimates. They have had more experience with study and cleanup activities. DOD has more data than when the 1988 estimate was developed. In 1988, very few studies or remedial actions had been completed. Also, DOD has been placing greater emphasis on the data in the data base because they are used to prepare budget submissions and the Defense Environmental Restoration Program Annual Report to Congress. Also, this time the services were more closely involved in the study to provide guidance to the contractor and resolve any differences in the way each service compiled its data. For example, the contractor and the services chose the type of DOD sites most likely to require remedial action and typical characteristics of each type of site (e.g., the average size). The contractor used several important methods and assumptions in building the estimate. The estimate covers only currently known sites, excluding installations overseas or nominated for realignment or closure under the Base Realignment and Closure Act of 1988. Historical costs for assessments and studies as well as operation and maintenance cost estimates for 10 years were used. After that time, the services must fund those activities with other funds. The contractor used EPA's computer model to estimate cost of remedial actions for different types of sites.

IR Program costs for installations overseas or nominated for realignment or closure in 1988 are covered separately. DOD is developing a plan to address remedial actions and cleanup for environmental problems caused by past activities at overseas installations. These installations are not included in the IR Program. Cleanup costs for installations to be closed or realigned in the Base Realignment and Closure Act of 1988 have an exclusive source of funding—the Department of Defense Base Closure Account 1990. DOD's July 1991 estimate of the cost to complete Defense Environmental Restoration Program activities at these installations is about $710 million.

Installations recommended for closure or realignment in July 1991 by the Defense Base Closure and Realignment Commission are not funded exclusively by the Closure Account, and therefore, were included in

DOD's current estimate. DOD has used some Defense Environmental Restoration Account funds for remedial action activities on these installations. DOD estimated that it will require over $2.5 billion[3] from fiscal year 1992 until the completion of the Defense Environmental Restoration Program activities at these installations. The majority of the funding for the 1991 closure or realignment installations will come from the Defense Environmental Restoration Account for fiscal years 1992 and 1993, according to one DOD estimate. DOD estimated it will require a total of $546 million for fiscal years 1992 and 1993 from the Defense Environmental Restoration Account and about $50 million from other sources.

Some of the installations recently nominated for closure or realignment have significant pollution problems; 14 installations—9 nominated for closure and 5 nominated for realignment—are on EPA's National Priorities List. Two of the installations nominated by the Commission for realignment have two National Priorities List sites each.

To date the cost of the IR Program has been small compared to what it could be in the future. There has been relatively little requirement for cleanup funds so far. From fiscal years 1984 to 1990, the Defense Environmental Restoration Account was appropriated $2.7 billion, of which $2.3 billion went to the IR Program. Of that $2.3 billion, about $465 million (1991 dollars) was used for remedial actions; the balance was spent to assess and study identified hazardous waste sites. DOD projects that $18.9 billion of its current $24.5 billion estimate (almost 78 percent) will be used for remedial actions and corresponding monitoring or treatment.

The study phase of the IR Program continues, and as it does, the outlays will continue to be relatively small. According to figures in the latest draft estimate and report, DOD expects that remedial actions will cost between 8 and 12 times more per site than the study phase. Therefore, when IR Program sites move further into the remedial action or cleanup phase, annual outlay requirements will likely increase significantly.

Problems in Projecting DOD Cleanup Costs

Although DOD has better data for estimating cleanup costs than it did 5 years ago, the reliability of the estimates are still constrained by several important factors. These factors include: (1) all the sites that DOD may ultimately have to clean up may not have been identified,

[3]Not included in this estimate was cost to complete estimates beyond fiscal year 1993 for Army realignment installations

(2) studies to identify what contamination is in the sites have not been completed, (3) some installations will require more extensive cleanup than anticipated, and (4) timing of the cleanup is not known and the longer it takes DOD to begin the cleanup, the higher the cost will be.

The scope of the newest estimate represents only a subset of all DOD sites to be studied and perhaps remedied in the future. It covers only currently known sites. No estimate of the number or cost of potential future sites was included. Also, installations overseas or nominated for realignment or closure in 1988 are not included in the estimate. This estimate does not represent DOD's full potential cleanup liability.

The number of sites at active installations has doubled since 1988. The number of new sites increased by almost 3,000 in fiscal year 1988, by almost 6,300 sites in fiscal year 1989 and by about 3,000 in fiscal year 1990. Even though the rate of increase slowed last year, the increase is still significant. Although DOD environmental officials do not expect to discover any new sites requiring extensive cleanup, each site will require some action to assess the extent of contamination and any remedial action necessary.

The contents of many hazardous waste sites are unknown, as most studies are still in progress. As of September 1990, 13 percent of the studies have been completed, 65 percent are underway, and 22 percent are planned for the future. To date, the average amount of time DOD has taken to study its National Priorities List sites is about 4 years per site. Many of these site studies are not completed and some have been in progress for over 6 years. In fact, some sites are still in the assessment phase. As of September 30, 1990, almost 20 percent of the sites were in this phase, with assessments underway or scheduled in the future. Since the studies have not been completed, it is not always easy to predict the cleanup technology necessary for a site. Therefore, it is difficult to predict the cost of remedial actions.

McClellan Air Force Base and Aberdeen Proving Ground provide two examples of cleanups requiring more extensive efforts than originally planned. In November 1983, we reported[1] that DOD's IR Program work at McClellan Air Force Base had identified two major areas of concern. First, additional work was needed to clean up a small polychlorinated biphenyl site. Second, a major groundwater monitoring effort on and off

[1]Status of Air Force Efforts to Deal With Groundwater Contamination Problems at McClellan Air Force Base (NSIAD-84-37, Nov. 29, 1983).

base was needed because the upper aquifer under the base had been contaminated. The study phase identified 46 sites needing cleanup with an estimated cost of around $29 million.

However, as further IR Program work was continued at McClellan, it was determined that not only had the upper aquifer been contaminated, but the contamination had also migrated lower. In addition, the number of sites with contamination and resulting cleanup required increased. In its 1991 annual report, DOD stated that McClellan was listed on EPA's National Priorities List with 177 sites needing cleanup. With the additional contamination and number of sites, the IR Program funding to date for McClellan is $61 million.

In April 1985, we reported[5] that the Army had identified six contamination sites at Aberdeen Proving Ground, Maryland, and that only four of those had been scheduled for study. As further work was completed at the base, additional contamination was found and, by the end of fiscal year 1988, the number of sites needing assessment increased to 178. In 1990, Aberdeen Proving Ground was placed on EPA's National Priorities List with 57 sites in the study phase.

DOD's latest cost estimate assumes that the IR Program will run through 2011, with all the studies completed by 1996. However, almost 90 percent of the IR Program studies still have to be completed. After completing the assessment phase on over 95 percent of its 17,482 potential active installation sites, DOD has identified almost 7,000 such sites that require further study. Of these sites scheduled for study, slightly over 900 have been completed. If the studies extend beyond 1996, inflation and changing regulatory standards could drive the ultimate cost of cleanup higher. On the other hand, advancing technology could affect the length of remedial actions, in addition to increasing or decreasing the price of remedial actions further in the future. New technologies could increase the ability to measure contaminants, thus some cleanups may have to comply with tougher standards than originally anticipated. The cost of cleanup and the time necessary could increase if the standards are tougher. On the other hand, technological developments may provide faster and/or better cleanup possibilities that cost less. Either way, EPA, state, and local regulations and standards are continuing to change, usually becoming tougher. The longer cleanup is delayed, the more likely a site will have to be cleaned up to stricter standards than anticipated.

[5]Efforts to Clean Up DOD-Owned Inactive Hazardous Waste Disposal Sites (GAO/NSIAD-85-41, Apr. 12, 1985)

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